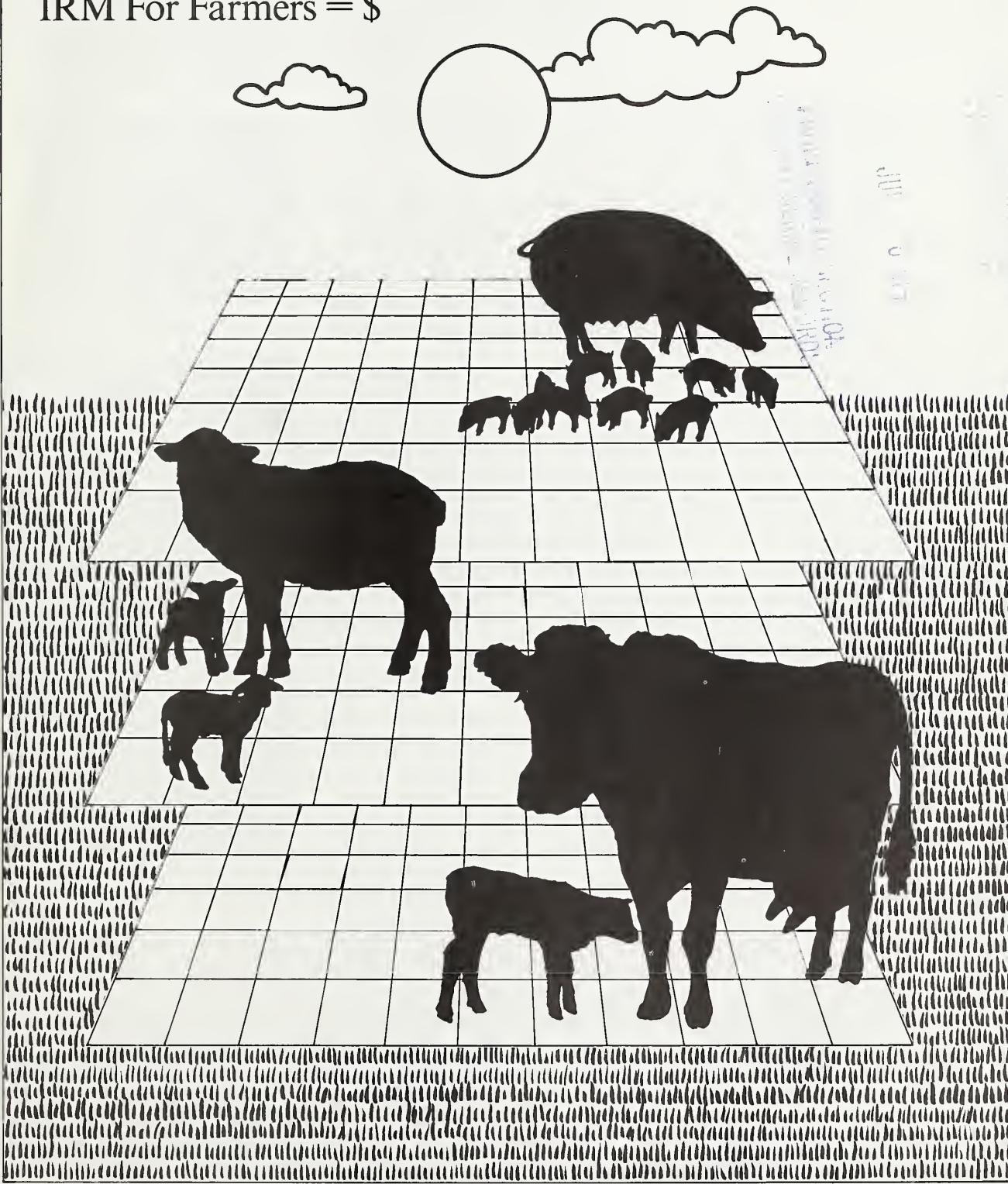


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Agricultural Research

Ag84
IRM For Farmers = \$



ARS Helped Pioneer Biotechnology Research

ments before the articles are off the press. Biotechnology promises to yield a nearly infinite number of improvements in just about every enterprise, from health care to waste management. And most forecasters predict that agriculture is the industry that will reap the greatest benefits.

The experience of the Agriculture Research Service with biotechnology goes back decades, long before the concept got its name. A milestone achievement was our classic research in photoperiodism. This work, begun by Wrightman Garner and Harry Allard in 1918, culminated when Harry Borthwick and Sterling Hendricks showed that flowering and seed formation are controlled by a chemical, now called phytochrome.

The pioneer work of these four scientists pointed the way to exploiting other natural substances to control plant growth and development. Today, this area of research, when conducted at the level of cells and molecules, is called bioregulation.

Another ARS milestone in biotechnology was the deciphering of the molecular structure of a ribonucleic acid (RNA) by a team of agency and Cornell University scientists. That achievement won the research team's leader, Robert W. Holley, a share of the 1968 Nobel Prize for medicine or physiology.

The team's work enabled other scientists to determine the structure of the remaining RNA's. A few years later, the method was modified to track down the sequence of nucleotides in various bacterial, plant, and human viruses. Modified further, the Holley team's approach is playing a role in determining the sequence of DNA's in today's chromosomal research.

Other examples of ARS achievements in biotechnology include:

- A vaccine against foot-and-mouth disease, developed through recombinant DNA technology in collaboration with Genentech, Inc.
- A vaccine against Marek's disease of poultry, developed with cell-culture techniques.
- A genetically engineered antigen, developed in cooperation with Genex Corp., that helps protect chickens against one parasite that causes coccidiosis. This could lead to a vaccine.
- New rice plants, developed through tissue culture, with more and better quality protein.
- Discovery of movable gene elements in soybeans

To say that biotechnology is dynamic is an understatement. Progress in this field is so rapid today that papers published in scientific journals are often eclipsed by new developments before the articles are off the press.

Biotechnology promises to yield a nearly infinite number of improvements in just about every enterprise, from health care to waste management. And most forecasters predict that agriculture is the industry that will reap the greatest benefits.

that may prove an important key to genetic engineering of economically valuable plants.

ARS research on cell membranes is internationally known. A top priority in membrane research is developing crop varieties that "harvest" more sunlight, resulting in healthier, more efficient plants and bigger yields.

Other current ARS research involving biotechnology includes:

- Devising a way to microinject genetic material into plants whose tough cell walls currently limit the practice to animal and human cells.
- Genetically engineering a vaccine against vesicular stomatitis, a viral disease of livestock that also affects humans.
- Transferring organelles and their DNA genes between plant species so that breeders can raise crop yields or impart resistance to herbicides, pests, or diseases.

We are making major efforts to find ways to culture single cells from a wide number of agronomic plants and to regenerate them into whole organisms with the genetic message intact and properly expressed. In animals, embryonic single cells—the fertilized egg—may well be the recipients for gene transplants.

New opportunities exist for more pioneering work. For example, modern techniques allow much more detailed study of the defense systems in animals and plants than was possible in the past. New knowledge of the immune system in animals promises improved approaches for disease and parasite control and for faster, more accurate diagnosis.

To help us continue our pioneering role, the ARS 1985 budget includes \$26 million for biotechnology research. Some 200 ARS scientists are focusing on biotechnology in 165 projects at laboratories throughout the United States.

Last year, a new Plant Gene Expression Center was established at our laboratory at Albany, CA, and we plan to expand biotechnology research at Beltsville, MD, where funding for such work has already reached nearly \$8 million.

We also increased the number of postdoctoral scientists on 1- or 2-year appointments in our elite Research Associates Program. In 1984, there were 26; this year, there are 50. They will concentrate mainly on biotechnology projects in the animal and plant sciences. We know that both adequate funding and top scientists will be needed if ARS is to remain in the vanguard of biotechnology research.

Terry B. Kinney, Jr.
Administrator



Agricultural Research

COVER: ARS and cooperating agencies are using a new research approach called integrated reproduction management to identify major barriers to improved livestock reproductive efficiency. Story begins on page 6. (Cover design by Jean E. Newcomb)



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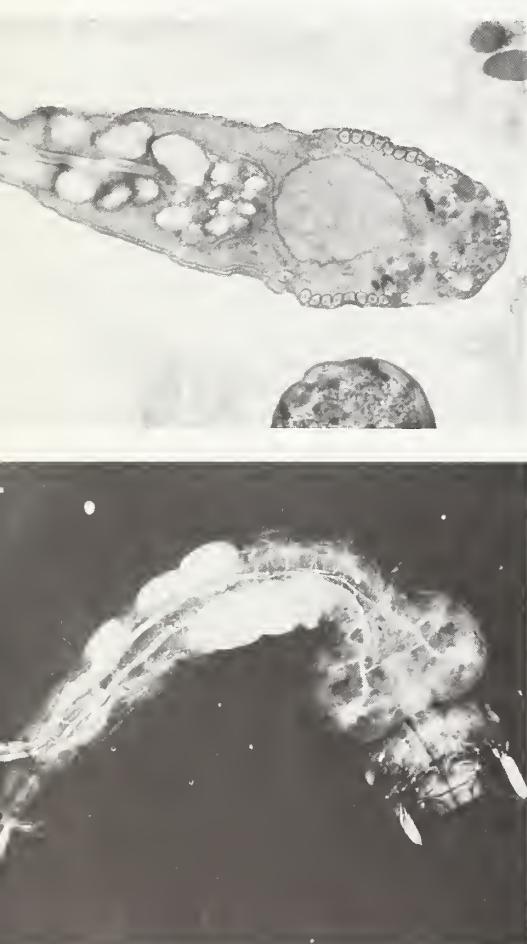
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Miniature Shellfish Help Control Mosquitoes

Tiny parasites of mosquitoes could soon be bred and released in swamps and lakes to control mosquitoes because of a discovery of a previously unknown link in the parasite's life cycle.

This biological control could help cities and states reduce and possibly eliminate the need for massive applications of chemicals, according to entomologists Major



Electron photomicrograph of "seed-like" protozoan spore in dormant stage (upper photo). When ingested by a mosquito larva (lower photo), the spore germinates resulting in the release of disease-causing organisms which will grow (white areas in the mosquito's gut) and eventually kill the larva. Electron photomicrograph by Tony Sweeney (PN-7155), macrophoto by James Bechen (PN-7154).

Tony Sweeney with the Australian Army Malaria Research Unit in Ingleburn, Australia, and the late Edwin I. Hazard of the Agricultural Research Service in Lake Charles, LA.

Microcrustaceans, which are small relatives of crawfish and crabs, are essential links in the life cycles of certain parasites of mosquitoes, the scientists say.

"Although we have long known of the existence of these mosquito parasites, we did not know about the intermediate microcrustacean link until it was discovered in Australia by Major Sweeney in a collaborative project with Hazard of our Gulf Coast Mosquito Research Laboratory," says Tokuo Fukuda, who is the acting research leader at Lake Charles. "The discovery of this link is important because it reveals how certain diseases are transmitted to mosquitoes and may give us a biological tool for controlling them," Fukuda says.

The parasites live inside microcrustaceans and produce infectious spores that are released into the water. Mosquito larvae feed on these spores, become diseased, and die before they can emerge as biting adults, the scientists said.

Large numbers of microcrustaceans live in ponds, lakes, and rivers and normally feed on algae, bacteria, and even newly hatched mosquito larvae. However, the scientists noted that only a few mosquitoes are eliminated this way under usual conditions.

Normally, 1 to 5 percent of mosquito larvae die after ingesting parasite spores every breeding season, Sweeney says. Although sometimes under unusual conditions, this parasite kills 80 to 90 percent of the mosquitoes.

"The scientists' goal was to learn to do routinely what nature does sporadically," Fukuda says. "They knew that in some infected mosquitoes, all male larvae die. In other species, all the larvae die. Either way, vast multitudes of mosquitoes could be naturally eliminated."

In many parts of the world, mosquitoes carry malaria, yellow fever, and other serious diseases. Of about 1,500 species of mosquitoes in the world, the United States and Canada have 167, Fukuda says. But even this relatively small number threatens the health of humans, livestock, and birds.

About 100 species of mosquitoes occur in Australia, particularly in the tropical north, Sweeney says. And now the key may have been found to helping nature bring down mosquito populations to small, easily controllable levels.—

Sam Shaffer, New Orleans, LA.

Tokuo Fukuda is located at the Gulf Coast Mosquito Research Unit, P.O. Box 16923, Lake Charles, LA 70601, and Major Tony Sweeney is at the Army Malaria Research Unit, Ingleburn, New South Wales, Australia. ■

Insecticides Don't Increase Codling Moths

A hypothesis has been proposed that, in the absence of insecticides, codling moths produce only one new generation a year, whereas, with insecticide use, they produce two or more generations a year. The moths are serious pests of deciduous fruit, especially apples and pears.

"Obviously, one generation a year would be much easier to control than two or more," says entomologist J. Franklin Howell at Yakima, WA.

He tested the hypothesis by determining what percentages of moth populations went into the dormant stage of their life cycle at both insecticide-free and commercially sprayed locations. He found that both sprayed and nonsprayed areas had similar percentages of single- and multiple-generation codling moths.

Whether there are one or two generations, he says, depends on air

temperature, which determines the time of the year the moths begin their development. Consequently, it is unlikely that the use of sterile males to disrupt mating or other biological control methods would affect the number of new generations produced each year.—**Lynn Yarris**, formerly at Oakland, CA.

J. Franklin Howell is located at the Yakima Agricultural Research Laboratory, 3706 W. Nob Hill Blvd., Yakima, WA 98902. ■

Folic Acid Excess May Lower Zinc

Vitamin pill poppers, take note. Taking the B-vitamin, folic acid, in large quantities could be harmful to your health.

This warning, resulting from studies by Agricultural Research Service and collaborating scientists, may apply most to persons with zinc-deficient diets and to pregnant women.

In one study on adult male volunteers living on-premises at the ARS Human Nutrition Research Center, Grand Forks, ND, chemist David B. Milne and his colleagues determined that about 200 micrograms of dietary folic acid per day may be sufficient. The current Recommended Dietary Allowance set by the U.S. National Research Council is 400 micrograms per day. Either amount can be provided easily by ordinary diets, says Milne.

Foods rich in folacin include liver, beans, nuts, and green and leafy vegetables.

Pregnant women usually require more folacin than do other women or men. But a joint study by scientists of Wright State University School of Medicine, at Dayton, OH, and ARS points to a danger of consuming too much folic acid, the normal supplementary form of this vitamin. Milne says the rather standard 1,000 micrograms beyond normal dietary amounts that obstetricians prescribed for some of the pregnant women in the

study may have been too much. Some of the women developed high levels of folic acid in their blood.

The group with elevated folic acid levels also had higher incidences of maternal infection, fetal distress, and other complications of pregnancy than did other pregnant women in the study.

The study on nutrition and pregnancy, led by Mukunda D. Mukherjee of Wright State University, included 43 kinds of measurements, including 12 of maternal nutrient status.

The scientists found fetus or maternal complications associated with low zinc and albumin levels in plasma in addition to high folic acid levels in the blood. In some cases, Milne suggests, supplementing diets with large amounts of folic acid may have impeded intestinal absorption of zinc.

That's also what may have happened in a study at the Grand Forks laboratory. Supplementing volunteer men's diets with 200 micrograms of folic acid per day increased the amount of zinc excreted in the stools and decreased zinc in urine by about 50 percent.

It's only in vitamin supplements that Milne sees folic acid as a hindrance to zinc absorption. Folacin that occurs naturally in foods has several attached glutamates that can be cleaved by a zinc-containing enzyme in the intestines, leaving a folic monoglutamate that can be absorbed into the bloodstream. But folic acid in vitamin supplements is already in pure monoglutamate form. When it reaches the acidic environment of the stomach, it appears to form an insoluble complex with zinc. Consequently, the zinc is not available for absorption when it reaches the intestines, Milne says.—**Ben Hardin**, Peoria, IL.

David B. Milne is located at the Grand Forks Human Nutrition Research Center, P.O. Box 7166, University of North Dakota, University Station, Grand Forks, ND 58201. ■

Computerized Assay for B Vitamins

Scientists can now use a new minicomputer program for biological assay of one of the B-complex vitamins in food—without having to rely on more expensive equipment already on the market.

The computerized technique along with programmable laboratory equipment gives results twice as fast as manual analysis, with less chance of human error, says Pamela Keagy, the program's designer.

Keagy, a food technologist with the Agricultural Research Service in Albany, CA, developed the program for her studies of the bioavailability of folacin in common foods. Folacin is the generic name for a group of compounds containing the B-vitamin folic acid.

The most sensitive technique available for measuring folate activity in foods, Keagy says, "uses a bacterium (*Lactobacillus casei*) that thrives on folic acid." The bacteria are planted on laboratory extracts of a food to be tested. The resultant growth is an accurate indicator of the usable amount of the vitamin in the food.

When done by hand, this type of assay is very time consuming. Keagy's solution: have the minicomputer perform the most tedious steps of the assay sequence, including dilution and mixing of the samples.

In the later stages of the assay, the computer quickly takes more than 50 readings of each sample tube, computes a median of the bacterial growth it finds, and records findings on both a floppy disk and strip charts.

The semi-automated assay technique shows potential for analysis of other vitamins as well, Keagy believes.—**Marcia Wood**, Albany, CA.

Pamela M. Keagy is located at Nutrients Research, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710. ■

Livestock Births More Timely and Rewarding



Animal physiologist H. D. Guthrie works to save more pigs at birth so that large litters of healthy animals—like the two he holds—may be raised. By controlling farrowing times with synthetic hormones, attendants can be present during birth, thereby reducing piglet deaths. (0485X365-14A)

Ask any farmer or rancher, livestock young seem to arrive only in the middle of the night. And they're right, at least as far as pigs go. U.S. Department of Agriculture scientists say only 13 percent of pigs are born during the day.

But times are changing. With new technologies developed at the Agricultural Research Center in Beltsville, MD, 60 percent of baby pigs can be born during a 12-hour period centered on the workday. In addition, weekend births are practically eliminated.

"Synthetic hormones, either added to feed or injected into sows, can shift the date and time of birth so someone is present and can help during delivery," says H.D. Guthrie, animal physiologist at the Reproduction Laboratory in Beltsville.

This study is a cooperative effort with the University of Delaware. Controlling the time when swine give birth could significantly reduce labor costs and allow better scheduling of farrowing facilities.

Changing the time of day that sows give birth is but one of many problems being studied under the Integrated Reproduction Management (IRM) program.

In swine IRM research at the Richard B. Russell Agricultural Research Center in Athens, GA, animal physiologist Robert R. Kraeling is cooperating with Mississippi State University in studies aimed at increasing the number of eggs females produce during ovulation. The scientists hope this will result in more pigs being born per litter.

Still another project with North Carolina State University involves increasing the number of pigs born per year for each brood sow by controlling the estrous cycle and time of ovulation.

Another technique that may prove valuable is weaning young pigs

from sows as early as possible without affecting the health and viability of the pig. The sooner young pigs are on their own, the sooner sows are ready to be rebred.

Scientists are also looking for ways to increase offspring survival by controlling reproductive-tract diseases in swine and other livestock.

At the National Animal Disease Center, Ames, IA, researchers are investigating the elusive pseudorabies, a herpes virus in swine.

"Pseudorabies can hide in the body undetected until something triggers its appearance," says George Lambert, chief of the Immunology Laboratory at the center.

The scientists at the center want to develop a nonliving or attenuated vaccine for the disease. Using genetic engineering, they hope to find a vaccine that can be used to control outbreaks that cost producers several million dollars annually.

Cooperators in the pseudorabies studies include scientists at Iowa State University and Purdue University at West Lafayette, IN.

More Efficient Beef Production

Lambert is also studying bovine brucellosis, a reproductive-tract disease of cattle that costs 65 to 90 million dollars annually for control efforts. Lambert heads a program to improve detection of the disease in cattle and develop improved vaccines for control efforts.

Cooperators include the University of Wisconsin, Texas A&M University, the University of California, the University of Florida, Louisiana State University, Auburn University in Alabama, Oklahoma State University, and the University of Hawaii.

The goal of another major IRM beef project is to reduce calf losses, which cost U.S. producers more than \$300 million annually.

"Delayed or difficult birth is the major cause of these losses," says ARS animal scientist Robert Bellows at the U.S. Fort Keogh Livestock and

(Continued on page 8)



Animal physiologist Robert R. Kraeling (right) and cooperating University of Georgia physiologist George B. Rampacek (second from right) conduct basic studies on how the brain of swine controls the pituitary gland which, in turn, influences the number of eggs females produce during ovulation. (0485X342-8)

Integrated Reproduction Management

Each year, dollar losses from livestock reproductive inefficiency and reproductive diseases exceed 4.5 billion. A new approach to reducing this staggering loss began in 1982 with funding from Congress specifically for an integrated reproduction management program.

Known as IRM, the approach effectively combines the multidisciplinary expertise and resources of land-grant universities with those of USDA's Agricultural Research Service, Cooperative State Research Service, and Extension Service. In addition, a number of industry groups and individual farmers advise research planners and assist the program in

many ways.

Space did not permit the accompanying article on integrated reproduction management to do justice to the full scope of IRM research at all locations. However, research on improving turkey reproduction efficiency will be featured in the May 1985 issue of *Agricultural Research*.

Much of the information on IRM was furnished by Roger J. Gerrits, National Program Director for Animal Production and Dyarl D. King, National Program Director for Animal Protection, Beltsville Agricultural Research Center, Bldg. 005, Beltsville, MD 20705.—L.E.M. ■

Livestock Births More Timely and Rewarding

Range Research Laboratory, Miles City, MT. Bellows coordinates IRM beef research, which includes cooperative research between ARS and State Agricultural Experiment Stations.

Cooperative studies include the following:

Montana State University scientists are collecting sire data to predict calving difficulty. They are also looking at how various body measurements in heifers might be associated with calving difficulty and reproduction.

Another major constraint to more efficient beef production is the length of time it takes cows to come back into heat after calving. If a cow is not in heat within 60 days after calving, she may not conceive and thus will not produce a calf 1 year later.

Scientists at Idaho State University are gathering information on how diet protein content, heifer body condition, and changes in blood composition may relate to delayed or missed pregnancy.

University of Nevada scientists are studying microscopic and chemical changes in reproductive tracts and hormone levels as possible clues to what causes delayed or missed pregnancies.

Washington State University scientists are studying the effects of energy levels and cow body condition on pregnancies.

Scientists at the University of Wyoming are collecting data to determine effects of cow body condition and pelvic size on calving difficulty and to pinpoint factors—such as temperature and wind chill—that affect reproductive efficiency.

A survey of ranchers by Oregon State University is aimed at developing a usable data base from which to identify factors such as cow and calf weights, age, breed, and history of calving difficulty. This will be used to develop management recommendations for beef producers.

Scientists at ARS' Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE, are study-



Top: Veterinary medical officer Billy J. Deyoe prepares to vaccinate a group of beef heifer calves with an experimental vaccine to prevent abortions caused by brucellosis. (0485X319-30)

Above: Microbiologist Eugene C. Pirtle, at a laser densitometer, studies banding patterns or "fingerprints" of pseudorabies viral DNA. Because pseudorabies strains fall into groups with their own distinct fingerprints, developing a method to identify them is a high research priority, Pirtle says. Such knowledge would pinpoint the origin of the infecting virus and help select the most effective countermeasure should a field outbreak occur. (0485X323-4A)





Above: This cow and calf are part of an ARS research study at Miles City, MT, in which scientists are looking for ways to assure that cows are ready for rebreeding 60 days after calving and give birth every year. The studies are continuing and are being complemented by State research stations that are sharing IRM funding. (0782X813-I4A)



Animal physiologist Robert A. Bellows uses a heifer pelvic bone to show how a pelvimeter is used to measure the pelvic area of live heifers. Pelvic area size is a major factor in determining the ease with which cows will calve. Bellows and his ARS colleagues, working with Montana State University scientists, are relating pelvic size and calf birth weight to calving difficulty. (0782X806-28A)

Left: Lyle D. Miller, of the College of Veterinary Medicine, Iowa State University, is cooperating with scientists at the National Animal Disease Center at Ames, IA. Miller is studying how the pseudorabies virus exists in an animal's brain cells in a partially formed or "incomplete" state. An unknown mechanism later triggers the brain cell to manufacture the virus in a "complete" state. If scientists can determine that mechanism, perhaps methods can be developed to prevent the virus genesis from occurring. (0485X321-24)

ing ways to improve beef cattle reproductive efficiency by taking advantage of twinning. Twins reduce feeding costs because a cow pregnant with twins eats little more than a cow bearing only one calf.

"Cows that have a history of producing twins continue to produce them in high frequency in this project," says ARS animal geneticist Keith E. Gregory.

"Daughters of test cows that have produced two or more sets of twins produce twins at a frequency that is more than eight times the rate of females of the same age and breed in normal herds," says Gregory.

"Our goal is to determine the heritability of multiple births in cattle, then calculate how fast this improvement can be incorporated into commercial herds," says ARS animal physiologist J. Joe Ford.

More Efficient Milk Production

For a study of dairy cattle, scientists at the University of Idaho surveyed 149 dairy farmers and found that they failed to detect when cows or heifers were ready for breeding in about 50 percent of the occurrences.

Robert C. Lamb, dairy coordinator for IRM at Utah State University, says, "This translates into missed opportunities to rebreed females and produce new calves, either for market or for replacement in herds."

The farmers surveyed had calf losses ranging from 2 to 70 percent, with the average being 21 percent.

Lamb and his colleagues started the project by collecting all available data on calf survivability and showing farmers how to apply the findings to everyday operations.

For example, they showed farmers how a simple iodine application on newborn calves' navels reduces mortality by up to 8 percent.

Other demonstrations emphasized equally simple management techniques that were reported in scientific literature but not widely known by the dairy industry.

Washington State University and ARS are attempting to develop a simple, onfarm test to determine pregnancy in dairy cows. They hope to measure hormone levels in milk samples and have results in half an hour.

A longer term project is to determine if calf survivability varies among the offspring of different bulls. This will combine the research expertise of scientists at the University of California and ARS scientists at Utah State University.

A survey now underway at Utah State should result in an evaluation of dairy reproductive management practices, complete with how much money is lost or saved on each practice. This would enable dairy managers to pick those practices that will have the greatest potential to increase reproduction efficiency.

Harold Hawk, chief of ARS' Reproduction Laboratory, Beltsville, is investigating whether the level of

progesterone found in milk is an overall indication of reproduction efficiency.

Spring Lamb Should Be Year Round

A major project directed by ARS geneticist Charles Parker at the U.S. Sheep Experiment Station, Dubois, ID, is to get sheep to breed out of season. Sheep normally breed in late fall and give birth in March and April. This creates a market glut when all lambs are ready for slaughter at roughly the same time—September and October.

"Research focuses on shifting the breeding season to March and April. Lambs would thus be available for market around February when prices generally climb to an Easter peak," says Parker.

In 1983, the scientists successfully lambed 190 out of 377 Polypay ewes in August and September by synchronizing their estrous cycles in early spring. Ninety-eight percent of these lambs survived and were ready for market in February.

"This shift would also cut feed and labor costs. Ewes require more feed when they are pregnant. Under the current breeding pattern, ewes are pregnant during the winter months when much of the feed is from storage. Diets for ewes with the shifted breeding season could come mainly from grazing," says animal physiologist John N. Stellflug, also with the U.S. Sheep Experiment Station.

Because most lambs are born in early spring when weather can be harsh, ARS scientists and those at the University of Idaho, the University of Wyoming, and Washington State University are using weather data to develop management practices to prevent cold stress and disease problems in newborn lambs.

All of these scientists are working together to translate agricultural research on integrated reproduction management into annual savings of hundreds of millions of dollars for producers and ultimately the consumer.—Dennis Senft, Albany, CA. ■



Above: Twin calves at the U.S. Meat Animal Research Center, Clay Center, NE. (0882X956-36)



Left: Near the U.S. Sheep Experimental Station, Dubois, ID, pregnant ewes move through a sub-Alpine forest on the way to their summer pasture. Researchers shifted the normal pregnancy season from winter to summer so the ewes can get more of their feed from pasture, instead of storage feed. (0779X973-9)

Paired Rows Push No-Till Grain Yields Up

A new method of planting wheat and barley promises to make conservation-tillage yields more competitive with conventional tillage yields in the Pacific Northwest.

Conservation tillage is a rapidly growing practice in which farmers reduce the amount of cultivation, leaving enough of the previous crop's residue on the surface to lessen soil erosion.

"Conservation tillage is gaining popularity throughout the country as a means of decreasing erosion," says Robert I. Papendick, research leader and soil scientist with the Agricultural Research Service at Pullman, WA. "Conservation tillage also has potential for saving energy by reducing the number of times a tractor has to cross a field."

The energy-saving possibility gave conservation tillage quite a boost in the seventies when diesel fuel prices were rising sharply, Papendick says. However, one thing that has held it back is that sometimes crops yield less with conservation tillage than with conventional methods.

For example, Papendick says, "In the past, wheat, barley, and other small grains have not yielded as well when planted with conservation tillage as when planted with conventional tillage or plowing. However, by combining the paired-row concept with conservation tillage, our test plots are yielding at least as much as conventionally tilled plots."

Paired-row planting places two seed rows 5 inches apart with a 15-inch separation between the row pairs. This contrasts with conventional grain plantings where rows are evenly spaced at about 7-inch intervals.

Preliminary test results indicate paired-row planting combined with conservation tillage controls soil erosion without sacrificing yields, says Papendick.

Papendick is using the USDA III No-Till Drill—an experimental seed drill—on the paired-row test plots. It simultaneously plants seeds and applies fertilizer in one pass across a field.



The USDA III No-Till Drill, designed for planting small grains in the rolling hills of the Pacific Northwest's Palouse, is the first no-till planter that can place a full season's fertilizer, either between paired rows or with the seed. (1184X1674-11A)

"The no-till drill allows us to get satisfactory penetration through thick crop residue, good seed-to-soil contact, and excellent fertilizer placement," says microbiologist Lloyd F. Elliott, also at Pullman.

The drill was developed cooperatively by ARS, Washington State University, and the Yielder Company of Spokane, WA.

Elliott says, "During seeding, one set of double disks places fertilizer, such as aqua ammonia, in the middle of the 5-inch space between paired rows. At the same time, the disks cover the fertilizer with a layer of soil, which prevents the fertilizer from rapidly volatilizing. If necessary, the drill can also apply small amounts of fertilizer with the seed."

"Paired-row planting offers possibilities for more efficient fertilizer use," says Elliott. He says that placing the fertilizer only between and under the seed rows—with no fertilizer in the 15-inch space between the pairs of rows—tends to "hide" the fertilizer from weeds.

Elliott says, "We don't know why, yet, but paired-row planting also appears to improve early seedling vigor."

Papendick says the Pacific Northwest is an ideal place for paired-row, conservation-tillage planting. "Annual soil erosion in this area can be held to less than 2 tons an acre with conservation tillage," he says. "This compares with a possible soil loss of 20 tons an acre or more from land planted with conventional tillage."

Papendick and his colleagues at Pullman are also testing a promising conservation-tillage implement developed in Great Britain in 1981. Known as the Paraplow, it is actually not a plow but a series of staggered chisels mounted on a plow frame. Each chisel has a leg that goes straight down and then bends to the side at a 45° angle. When the chisels are pulled through the soil, soil flows over each bent wing, as air flows over an airplane's wings.

Paired Rows Push No-Till Grain Yields Up

The Paraplow lifts the soil just an inch or less, only slightly disturbing the soil surface. Elliott says the "really revolutionary thing" about the paraplow is that it eliminates smearing, a compacting of wet, clayey soils when a chisel presses against them. The winged design limits smearing to a 2-inch-wide knob at the tip of each wing. By staggering the chisels, even that smearing is undone by the next chisel.

Keith E. Saxton, an ARS hydrologist at Pullman, says, "The Paraplow represents a major advance in soil-tillage equipment. It restores productivity in compact, eroded soils by breaking up dense soil layers, improving the rooting zone and the water intake."

Elliott modified the commercially built Paraplow to dispense phosphorus at depths of 14 to 18 inches.

"Deep fertilizer placement," says Elliott, "should encourage further rooting at greater depths and help restore soil productivity in marginal soils."

Papendick and his colleagues have used a Paraplow for fall tillage before planting spring wheat and barley with the no-till drill.

Papendick says, "We need to see what effects paraplowing combined with conservation tillage will have on water infiltration on nonirrigated croplands. Water-use efficiency is the number one dryland farming problem worldwide. It is particularly acute on the dry, eroded hillsides of the Pacific Northwest and similar areas of the world."

The Paraplow being tested at Pullman was produced by Howard Rotavator Company, Inc., in Muscoda, WI.—Howard Sherman, Albany, CA.

Robert I. Papendick, Lloyd F. Elliott, and Keith E. Saxton are at the Land Management and Water Conservation Research Laboratory, Washington State University, Johnson Hall, Room 215, Pullman WA 99164. ■



Above: In a test plot near Washington State University, Pullman, WA, early growth of paired row, no-till barley (left) appears more vigorous than the conventionally planted barley. Cooperating WSU microbiologist Diane Stott (now with ARS) and ARS microbiologist Lloyd Elliott observe the differences. (0884X1133-10)

Right: University of Idaho soil physicist John Hammel (right) and Lloyd Elliott are testing this British-designed Paraplow on the fragile soils of the Palouse. Angled Paraplow chisels restore productivity by loosening compacted soil. (0884X1135-14)



New System Hears Insects Chewing

A stethoscope head is pressed against a grapefruit. At the other end of an array of equipment, sounds come out of a loudspeaker. "That grapefruit's infested with fruit fly larvae," says engineer J.C. Webb. What Webb has heard is the sound of the maggots chewing on the fruit pulp inside.

Webb and other Agricultural Research Service scientists are listening for insects in fruit, nuts, and grain in much the same way physicians listen for internal disorders through a stethoscope.

Right now, there is no practical way to tell if produce is infested with larvae or not, according to Milton T. Ouye, ARS national program leader on product losses. "Take a grapefruit, for example," he says. "To find out if it harbors fruit fly larvae, you have to destroy it—usually by cutting it open and meticulously examining the pulp under a magnifying glass. But with Webb's system, you can detect an infestation in seconds, and you don't have to destroy the fruit."

Ouye cautions that the system is experimental and that some questions need to be resolved, such as the jarring of fruit or workplace noise that may interrupt the detection of chewing sounds. A workable system for shippers and state and federal inspectors is at least several years away, he says.

Lack of ways to detect larval infestations and the banning of certain fumigants jeopardize millions of dollars' worth of U.S. trade in certain fruits, Ouye says.

He explains, states and countries want to keep potential insect pests outside their borders, so they quarantine produce that is a possible carrier. This means that the produce—whether it is actually infested or not—cannot be imported unless it has received a specified treatment to kill any insects, and shippers today have scarcely any options. A treatment must not only satisfy quarantine officials' requirements for effectiveness and reliability, but it must also be economically feasible and environmentally safe.

Webb's detection system may satisfy quarantine regulations, Ouye says. "I believe the concept will be very useful in our ongoing research to find alternative—preferably nonchemical—quarantine treatments. It offers a way to gather information about infestations without destroying the fruit. And if the system proves to be usable in commercial settings, it might well be that treatment may consist of simply removing infested fruit before shipment."

Same As An Earthquake

Webb's detection system, which has been under development since the spring of 1983, is based on the same natural laws that make it possible to detect distant earthquakes with a seismograph. Solids and liquids vibrate when disturbed. The weak vibrations set going by larval feeding and movement inside a fruit travel outward in all directions to the skin and start it vibrating.

These vibrations, though undetectable by human senses, can be picked up by instruments placed against the fruit. "The best detector I've found," Webb says,



Alone with a grapefruit in a soundproof studio, ARS engineer J. C. Webb listens to the barely audible sound of tiny fruit fly larvae chewing grapefruit pulp. (0484X505-17A)

TECHNOLOGY



Above: Technician Shurchi Masuda detects chewing sounds of fruit fly larvae continuing to feed inside grapefruit that are bumped and jostled down a ramp designed to simulate packing plant conditions. (0484X502-19)



Above: Caribbean fruit fly laying an egg in a grapefruit. (0478X440-15A)



Just beneath a grapefruit peel, fruit fly larvae begin to devour the pulp. (0484X495-9A)

"is the membrane in the endpiece of a common medical stethoscope."

The stethoscope head can be hooked up through appropriate intermediary equipment to any of several devices; to a speaker, for example, so that the vibrations can be heard, or to an oscilloscope so that they can be seen, or a plotter so that they can be printed out in graphs. It can even be connected to a recorder or computer for data storage and analysis, he says.

In early laboratory testing, Webb and entomologist Carroll O. Calkins, both with ARS in Gainesville, FL, found that the system could reliably and quickly detect Caribbean fruit fly larvae (*Anastrepha suspensa*) in grapefruit, loquat, guava, and papaya. "Whenever we heard anything, we invariably found a larval infestation," Webb says. "As for the system's sensitivity, we found that we could detect, in a few seconds, a single 1-day-old maggot in a grapefruit. At that age the larva

is less than 2 millimeters (eight-hundredths of an inch) long." In ongoing work, Calkins is using the system to study the feeding habits and growth of Caribbean fruit fly larvae in grapefruit.

Hidden Insects In Grain

Beyond the quarantine application in fruit, the system has potential as a quality-control tool in the grain trade. Although grain is not subject to quarantine regulations because the most destructive grain pests are already distributed worldwide, shipments must meet standards of cleanliness. Says Ouye: "Methods in use today can detect insects living among the kernels, but they cannot detect larvae living in the kernels."

Over a year ago, feasibility testing was extended to detection of the larval stages of the lesser grain borer (*Rhyzopertha dominica*), and the Angoumois grain moth (*Sitotroga cerealella*) inside kernels of corn, rice, and wheat.

"I'm confident that this detection concept will eventually be useful in the grain industry," says entomologist Kenneth W. Vick, also at the Gainesville laboratory. "We've found that we can detect these insects in grain kernels during roughly the last half of their larval life except for about 3 days when they're molting. When they're molting, they're quiet. We've also been able to correlate specific noises with specific larval activities and relate the intensity of sound to the age of the larvae."

Vick sees the day when it will be possible to determine whether bulk grain is infested or not and the extent of infestation by inserting some sort of probe into a filled bin or elevator. His optimism is based on the progress made so far. "From being able to detect larval activity in a single grain kernel a year ago," he says, "we've reached the point where we can detect one infested kernel in a quart of uninfested kernels—speaking of wheat, that's about one kernel in 25,000. In the work ahead, we'll be trying to improve the sensitivity of the detection system as well as gaining more knowledge about larval behavior."

New Research Projects

Beginning in 1985, ARS laboratories around the country will begin testing Webb's detection system on other produce and insects of interest to quarantine officials. Webb will advise the researchers on the use of the equipment and continue to modify and improve it as new data become available.

Projects to detect the following are due to get underway soon—

- Mexican fruit fly larvae in grapefruit, oranges, and mangoes, at the Subtropical Crops Insects Research Unit, Weslaco, TX, under the direction of William G. Hart.
- Codling moth larvae in apples, at the Quarantine Treatment Research Unit, Yakima, WA, under the direction of H. Harold Toba.
- Codling moth larvae in walnuts, peaches, plums, and nectarines and of navel orangeworms in walnuts, at the Horticultural Crops Research Laboratory, Fresno, CA, under the direction of Charles E. Curtis.
- Oriental and Mediterranean fruit fly larvae in papayas, at the Commodity Treatment, Handling, and Distribution Research Unit, Hilo, HI, under the direction of John W. Armstrong.
- And development of reliability data acceptable to quarantine officials on the detection of Caribbean fruit fly larvae in grapefruit and mangoes, at the Subtropical Horticulture Research Unit, Miami, FL, under the direction of Jennifer Sharpe.—David Pyrah, New Orleans, LA.



Noises from lesser grain borer larvae inside a grain of wheat are graphically revealed by an oscilloscope. (0484X504-11)

J.C. Webb, Carroll O. Calkins, and Kenneth W. Vick are located at the Insect Attractants, Behavior, and Basic Biology Research Laboratory, P.O. Box 14565, Gainesville, FL 32604. Milton T. Ouye is with the ARS National Program Staff, Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■

PATENTS

Applicator for Postemergence Weed Control

Weeds always seem to win the early season competition with crops. But this recirculating weed wiper may give tender crops a better chance to compete with perennial pests, such as johnsongrass, bermudagrass, nutsedge, and cocklebur.

Designed as a postemergence herbicide applicator, the recirculating wiper allows band applications in crops during growth stages from cotyledon through the end of cultivation. It can also be used to apply herbicide to weeds growing above the crop or where soil contamination must be avoided.

This applicator overcomes several limitations of recirculating sprayers and rope wick applicators including: (a) crop injury from spray splatter; (b) clogging from plant debris and soil particles in the spray traps and supply tank; (c) amount of herbicide delivered not limited to the amount that can be carried in a rope wick; and (d) rope wicks dry rapidly under conditions of low humidity, high temperatures, and brisk wind.

The recirculating wiper is mounted across the front of a tractor. It consists of a 200-cm (80-inch) length of 20-cm- (8-inch-) diameter aluminum irrigation tubing, a pad of nylon carpet, a section of flat expanded metal, and standard spray nozzles.

The nozzles spray solution to the back of the carpet. The soaked carpet contacts the weeds.

For further technical information, contact James M. Chandler, Department of Soil and Crop Services, Texas A&M University, Rm. 337B, College Station, TX 77843. Patent No. 4,471,570, "Recirculating Wiper for Agricultural Chemicals." ■

Crop Growth Enhanced by Brassinosteroid

Brassinosteroid, a biologically active growth stimulator, enhances growth and development of various crops tested under greenhouse and field conditions.

Bush beans, barley, and lettuce responded best to brassinosteroid application during periods of active tissue growth, repeated spray applications of brassinosteroid, or one application of a brassinosteroid/lanolin solution. The application was most effective in increasing seedling vigor and hastening crop development.

Unlike auxin, gibberellic acid, or cytokinin, brassinosteroid at appropriate concentrations stimulates growth without altering the gross structure or form of the plant. It may reduce growth time significantly as well as reducing fertilizer requirements.

Brassinosteroid is a safe, readily biodegradable substance similar to a natural growth stimulator. It can be used at concentrations equal to or

far below currently used stimulators, making it an economical treatment to use. For further technical information, contact Malcolm J. Thompson, Plant Protection Institute, Beltsville, MD 20705. *Patent Application Serial No. 4,346,226, "Plant Growth Promoting Brassinosteroid."* ■

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